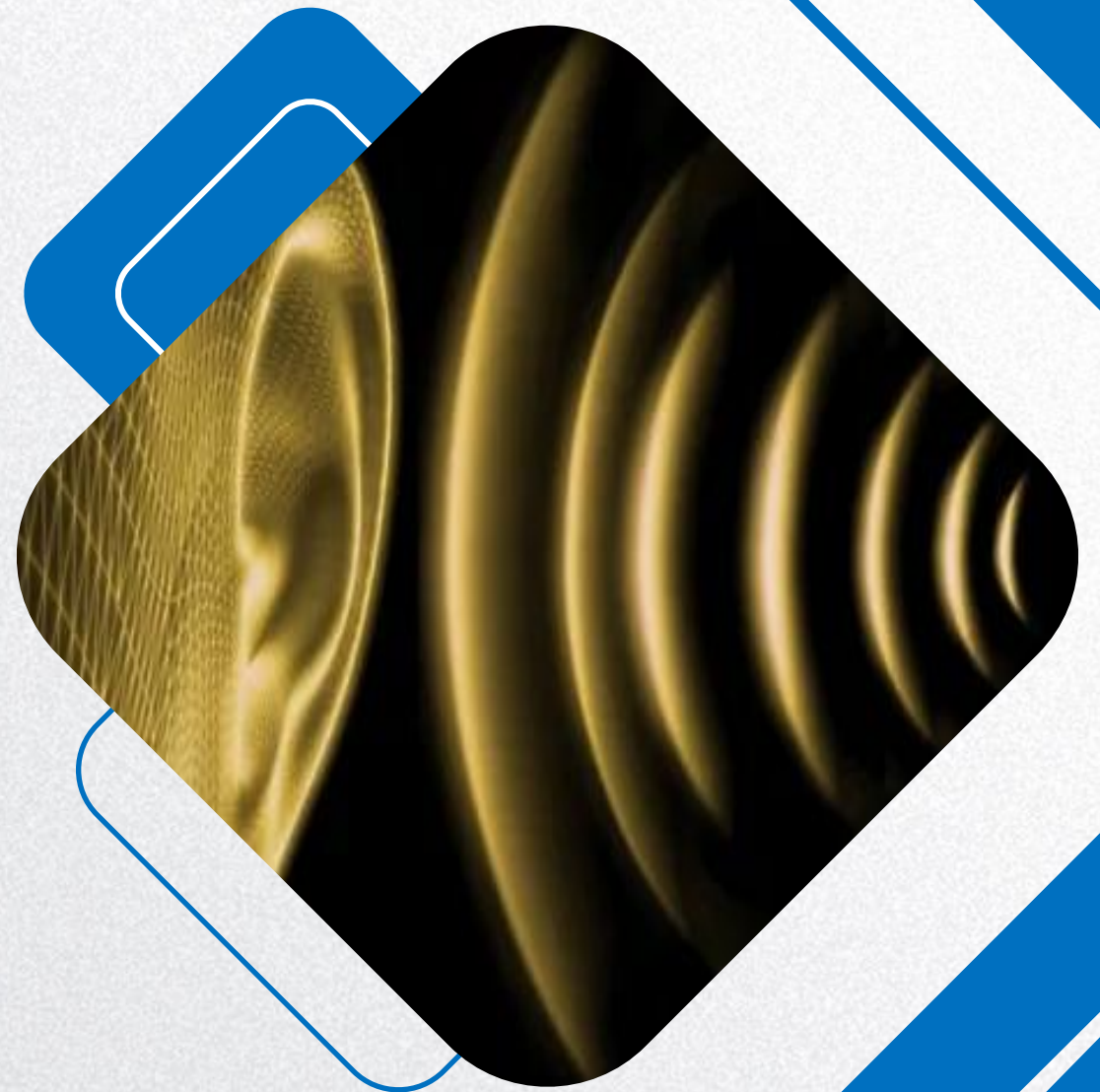


Importance of Acoustics

How sounds affect to daily life?

聲學之重要性: 聲音對日常生活的影響



Speaker : Mr. Fong Weng Chio (馮永超)



Contents



01 What is Acoustics?

02 Definition of Noise

03 Sound Transmission

04 Classification of Noise

05 Sound pressure that Human body can tolerance

06 Noise affect to health

07 How to avoid sound enter and transmission

08 Acoustic suggestion for residential architecture

01

What is Acoustics?



01

What is Acoustics?



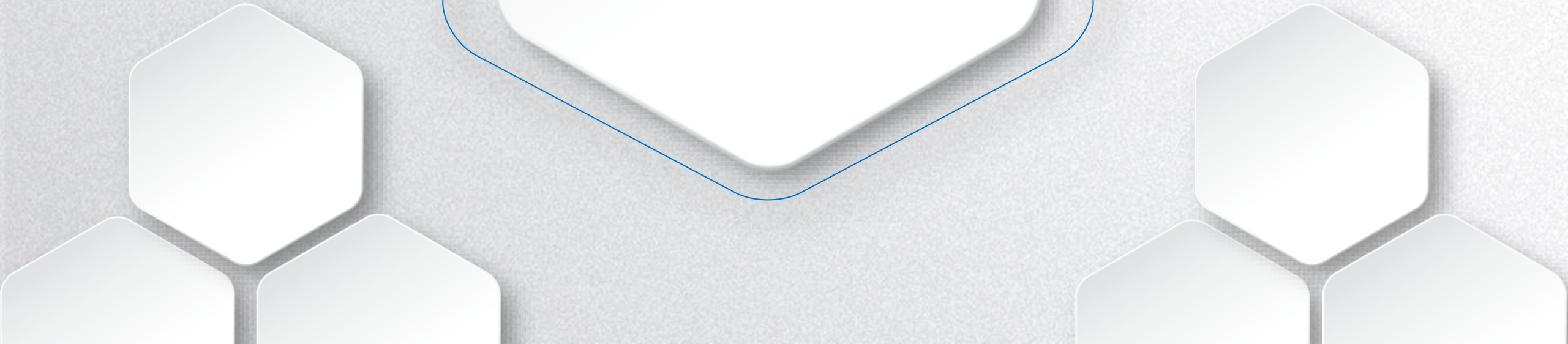
People learn about the science of sound. We perceive and hear sound through our ears.

There are acoustics categories as below:

1. Architectural acoustics (control of the acoustics of indoor spaces)
2. Physioacoustics (the impact of sound on the human body)
3. Psychoacoustics (the impact of sound on human emotions)
4. Bioacoustics (sound can be used for diagnosis, medical treatment, etc., such as ultrasound)
5. Marine Acoustics (Used in ships, warships, fishing, etc., e.g. sonar)
6. Vibroacoustics (vibration noise generated by walking on roads, highways, trains, trams, and common vehicles)

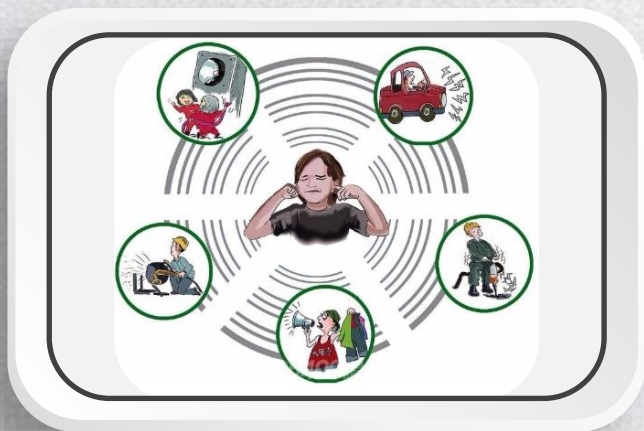
02

Definition of Noise



02

Definition of Noise



Subjective Definition

Sounds we don't like and want to hear, also annoying sounds.

「噪音管制標準」

第六條 營建工程噪音管制標準值如下：

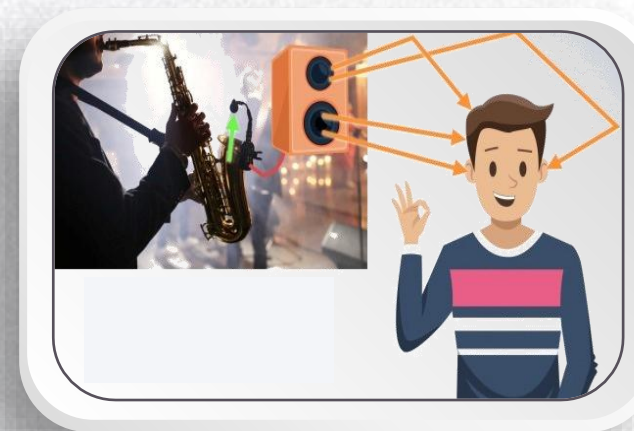
(低頻) (全頻)

音響 管制區	頻率 時段	20 Hz 至 200 Hz			20 Hz 至 20,000 Hz		
		日間	晚間	夜間	日間	晚間	夜間
均能 音量 (L_{eq})	第一類	44	44	39	67	47	47
	第二類	44	44	39	67	57	47
	第三類	46	46	41	72	67	62
	第四類	49	49	44	80	70	65
最大 音量 (L_{max})	第一、二類				100	80	70
	第三、四類				100	85	75

Objective definition

Sound that exceeds regulatory standards

- Full Frequency Noise (20Hz ~ 20kHz)
- Low Frequency Noise (20Hz ~ 200Hz)



On the other hand, when the sound we hear is joyful, it is called a pleasant sound.

03

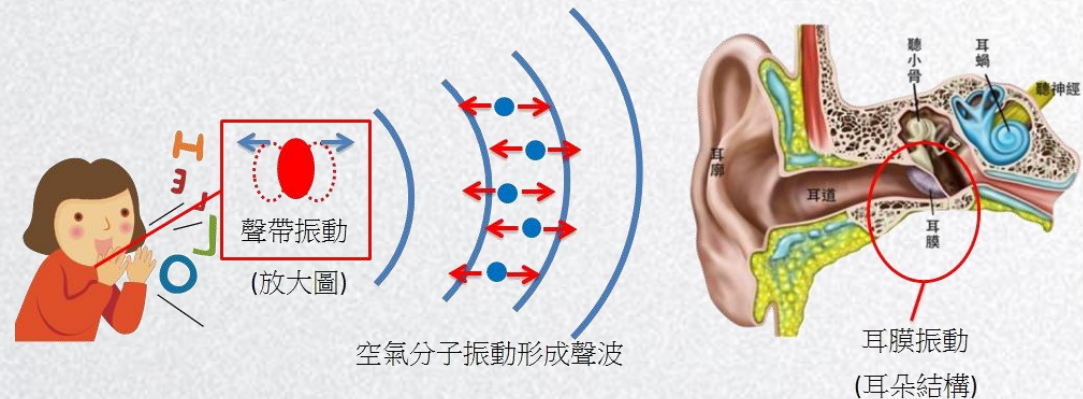
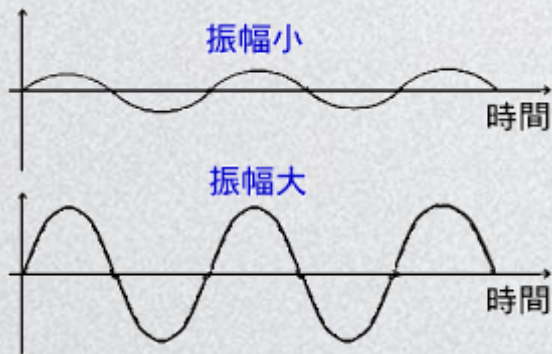
Sound Transmission



03

Sound transmission - how is the sound produced?

- Sound is **a wave phenomenon** in which the vibration of a sound source causes the molecules of the air and various substances in the vicinity to move and spread outward to form a pressure wave. The number of times a sound source vibrates per unit of time calls, frequency, and is usually expressed in terms of **Hertz (Hz)** per second.



- Composition of sound: the result of mixing from different “frequencies”.

High Frequency (4000~20000hz), Mid-High Frequency (500~4000hz), Mid-Low Frequency (250Hz~500Hz), Low Frequency (250Hz~15Hz)

- Sound volume level in decibels (dB)

03

Sound Transmission

- The transmission of sound is the transmission of energy medium, through the existence of medium such as air, solid, liquid transmission.
- The propagation rate of sound in the medium is: speed in the solid > speed in the liquid > speed in the gas, the sound is **Sound rate**.



Air



Solid

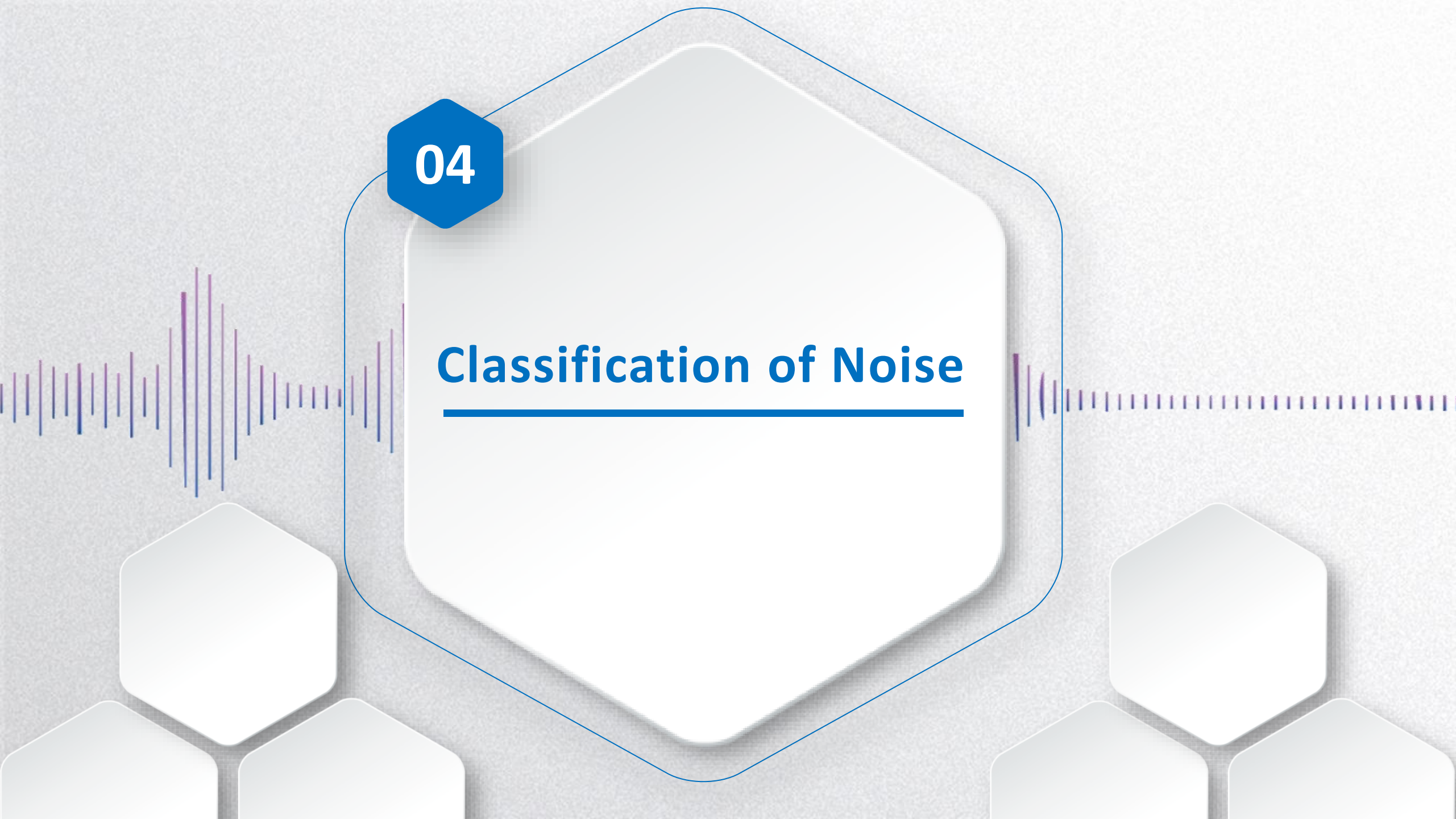


Liquid

- The higher of the weight and density of the medium, the faster and further of transmission speed, like earthquakes.

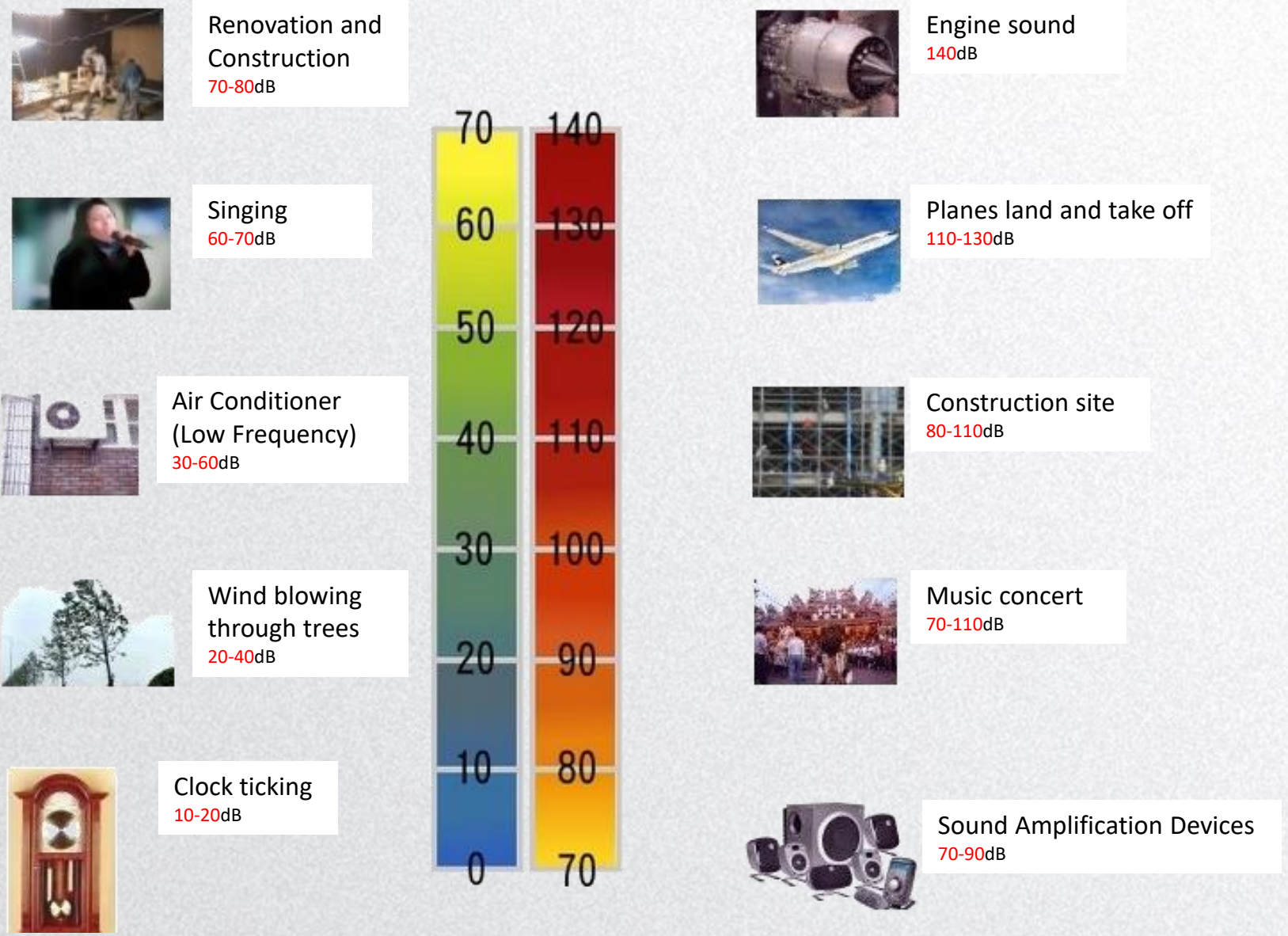
04

Classification of Noise



04

Classification of Noise



Renovation and Construction
70-80dB



Singing
60-70dB



Air Conditioner (Low Frequency)
30-60dB



Wind blowing through trees
20-40dB



Clock ticking
10-20dB



Engine sound
140dB



Planes land and take off
110-130dB



Construction site
80-110dB



Music concert
70-110dB



Sound Amplification Devices
70-90dB

05

**Sound pressure that human
body can tolerance**

05

Sound pressure that human body can tolerance



- Generally audible sound calls, **audible sound**, and its frequency range is 20Hz~20000Hz.
- The most sensitive frequency for human hearing is around 500~4000Hz in the middle and high frequencies, if someone can hear 20Hz~500Hz in the middle and low frequencies, the frequency range is 20Hz~20,000Hz.
- If someone can hear 20Hz~500Hz in the middle and low frequencies, then he will not be sensitive to 500Hz~4000Hz in the middle and high frequencies.
- On the other hand, a person who is sensitive to the high frequency of 4000~20000Hz is not very sensitive to the low frequency of 4000~20000Hz.

06

Noise affect to health

06

Noise impact to Health?

The “Psychological” and “Physical” impacts

Direct impact

- Auditory system;
- Hearing loss(temporary or permanent anacusis)

Indirect Impacts

- Unhappiness, anxiety, nervousness;
- Interference with sleep, reading, work, thinking;
- Headaches, digestive problems, increased blood pressure;
- The higher the noise level, the higher risk of high blood pressure. Every 10dB increase in noise level increases, result in high blood pressure risk by 6%.



06

How does noise cause psychological effects?

- If you stay in the same rhythm for a long time, also a fixed frequency of influence will produce anxiety, annoyance, anxiety, mental instability, hallucinations, resulting in depression or bipolar disorder, or even schizophrenia.

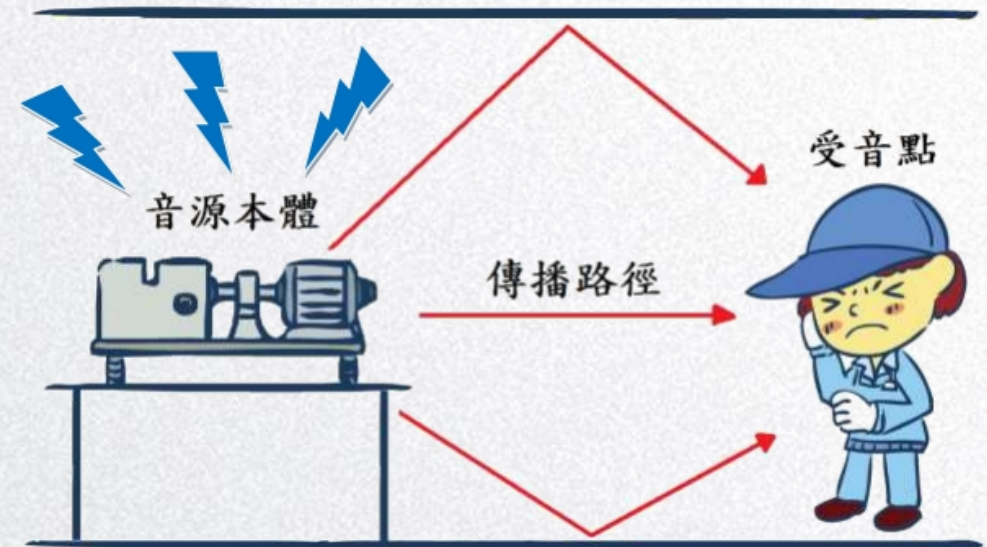


- When you leave a noisy environment, there is a long period of time when your psyche is still affected by the memory of the sound, and you feel that the sound still exists, and if you don't hear it, you will look for the familiar sound, which is called **“auditory retention”**.

06

How does noise cause physiological effects?

- Hearing loss occurs when the eardrums are damaged due to a combination of sounds, either physically or pathologically, resulting in **a loss of hearing**.
- The eardrum is subjected to **noise pressure that cannot be tolerated**, resulting in **otitis media** and **degenerative bone disease**.
- Damage to the sensitivity to sound, **long-term exposure to high noise environments** resulting in damage or death of auditory hair cells, leading to **permanent hearing loss**. (Above 80dB)
- Temporary hearing loss, such as being exposed to high noise levels for a short period of time, but hearing slowly recovers when you leave.



06

How noise impacts to Living quality



- Nowadays there is high population density, most of people live in high buildings. Whether they are on the same floor or not, but they **live together under the same building**. Because of **different living habits**, the **noise resulting** from the number of people living in the building **affects other's lives**.
- Building with **difference structure** that Noise **result in various affect** to others is also different.
- To prevent noise from affecting others, which is a challenge of social consideration.



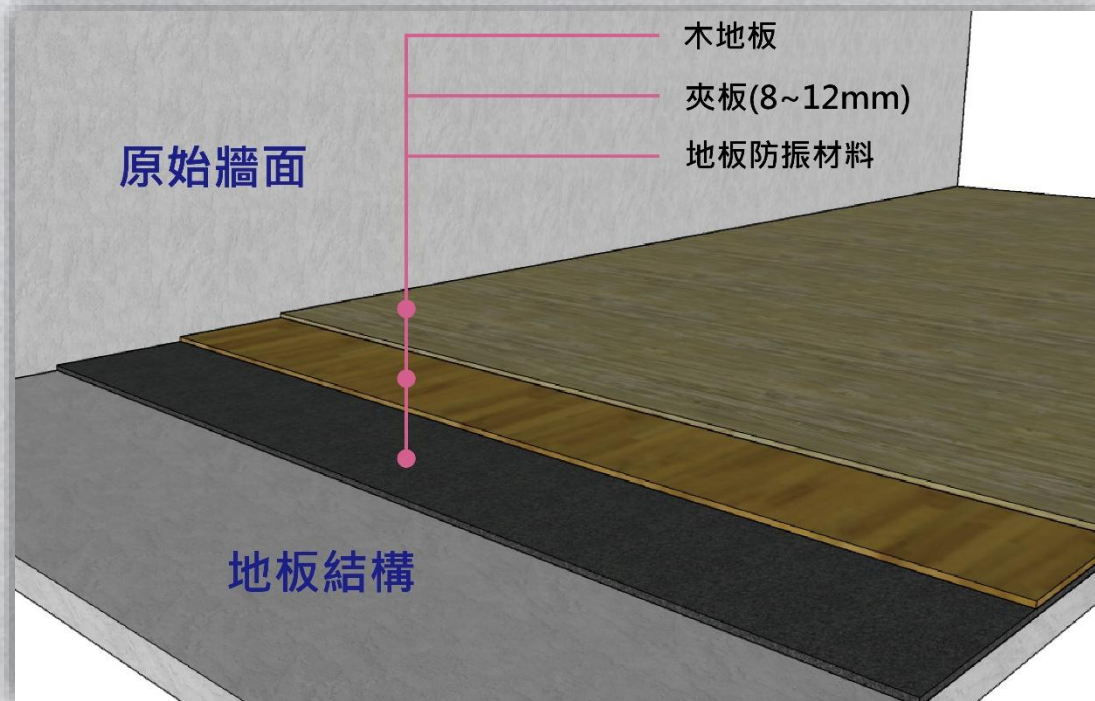
07

How to avoid sound enter and transmission

07

How to avoid sound enter and transmission

- House Common Noise: **Vibration Isolation, Soundproofing, Reverberation Echo**



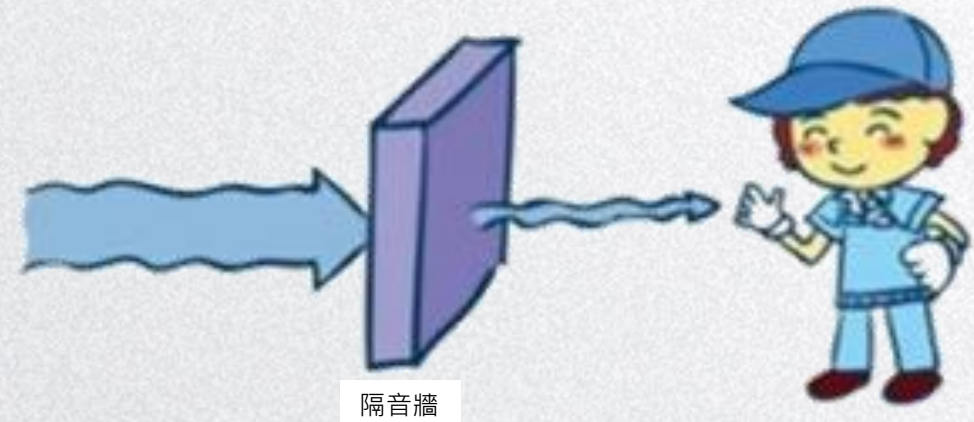
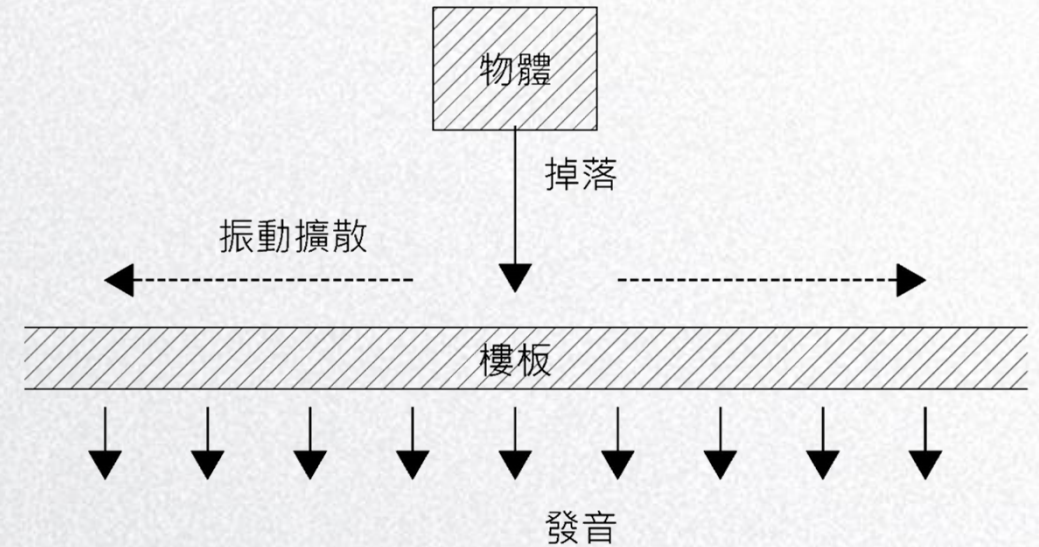
- Floor Platform :**

- Due to the pursuit of earthquake and wind protection in modern buildings, most of them are made of **steel structure**, and the floor compartments are mainly light and thin, resulting in weaker **sound insulation** and **vibration prevention**.
- Avoiding noise to neighbors, the floor firstly laying **anti-vibration materials**, and then lay the floor that can avoid the sound of walking footsteps, pulling tables and chairs or objects falling on the ground sound affect to downstairs.

07

How to avoid sound enter and transmission

- **Ceiling soundproofing:** :
 - Building an acoustic ceilings to **protect the upper floors from floor vibration noise.**
- **Wall soundproofing :**
 - Building a soundproof wall to enhance the **soundproofing capacity.** Adding an extra soundproof door room that will ensure a quiet living space;
 - Increase the soundproofing capacity of **soundproof doors;**
 - Improvement of the soundproofing capacity of **windows.**



07

How to avoid sound enter and transmission

Specialized spaces such as piano rooms, practice rooms, audio-visual rooms, etc. can be built to prevent noise from affecting the neighbors and disrupting the harmony.

- **Reverberant Echo :**
 - Building sound-absorbing materials on the surface of the piano room and audio-visual room can shorten the reverberant echo of music to achieve sound clarity;
 - Like, porous and open-cell materials: fiber wool and fiberboard.



07

Acoustic Ideal Specifications -Reference Case 1



Sound Isolation blanket
(pre-construction)



Sound Isolation blanket
(during construction)



Sound Isolation blanket
(after construction)

07

Acoustic Ideal Specifications -Reference Case 2



**Sound Isolation blanket
(pre-construction)**



**Sound Isolation blanket
(during construction)**



**Sound Isolation blanket
(after construction)**

07

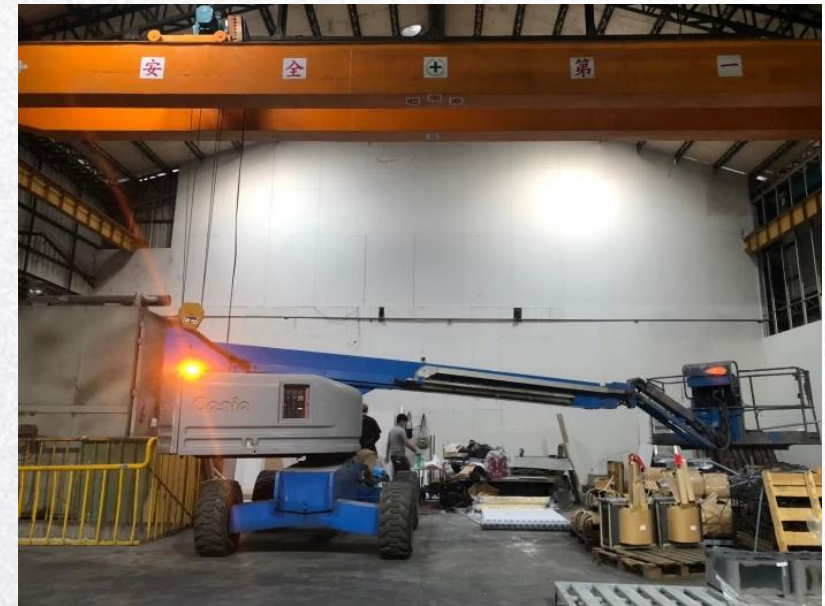
Acoustic Ideal Specifications -Reference Case 3



2.3cm Thick Composite Sound Insulation Panels (pre-construction)



2.3cm Thick Composite Sound Insulation Panels (during construction)



2.3cm Thick Composite Sound Insulation Panels (after construction)

07

Acoustic Ideal Specifications -Reference Case 4



2.3cm Thick Complex Sound Insulation Panels (pre-construction)



2.3cm Thick Composite Sound Insulation Panels (during construction)



2.3cm Thick Complex Sound Insulation Panels (after construction)



07

Acoustic Ideal Specifications -Reference Case 5



Polyester fiber vibration isolation blanket -
Wet construction
(pre-construction)

Polyester fiber vibration isolation blanket -
Wet construction
(after construction)

07

Acoustic Ideal Specifications -Reference Case 6



**Rubber Anti-Vibration Pad
(pre-construction)**



**Rubber Anti-Vibration Pad
(during construction)**



**Rubber Anti-Vibration Pad
(after construction)**



08

Acoustic suggestion for residential architecture

08

Acoustic Ideal Specifications



Split-wall soundproofing capability:
STC-50dB(A)



Floor vibration noise isolation:
Below $L_{nw}58dB$, $\Delta L_w-20dB(A)$

08

Acoustic Ideal Specifications

Acceptable Indoor noise levels for various types of buildings

Environment	Noise Rating (NR/NC) Curve Range	A-weighted decibel DB(A)
Factory	60~75	66~78
Mechanical room	50~55	56~61
Gym, Sport stadium, Swimming pool	40~50	47~56
Restaurant, Canteen	35~45	42~52
Office, Reading room	30~40	38~47
Cinema, Inpatient Rooms, Small Conference Room, Bedroom	25~35	35~42
Classroom, conference room, TV studio	20~30	30~38
Concert halls, theaters	15~20	25~30
Audiometry test room, Radio Studio	10~20	20~30

08

Acoustic Ideal Specifications -Reference Case 7

- Mr. Chan's House- Piano room



Outdoor playback noise source: Outdoor measured 105.6dB



Outdoor playback noise source: Outdoor measured 53.9dB

- **Testing result** : Soundproof wall reach to FSTC-51



Picture after construction

08

Acoustic Ideal Specifications -Reference Case 8

- Tainan National University of the Arts- Music Teaching Studio

- **Testing result:** : Total noise reduction of 28.2 dB at floor level



Vibration Isolated Floor Surfaces
Wooden flooring



Measurement Impact Sound 88.5dB

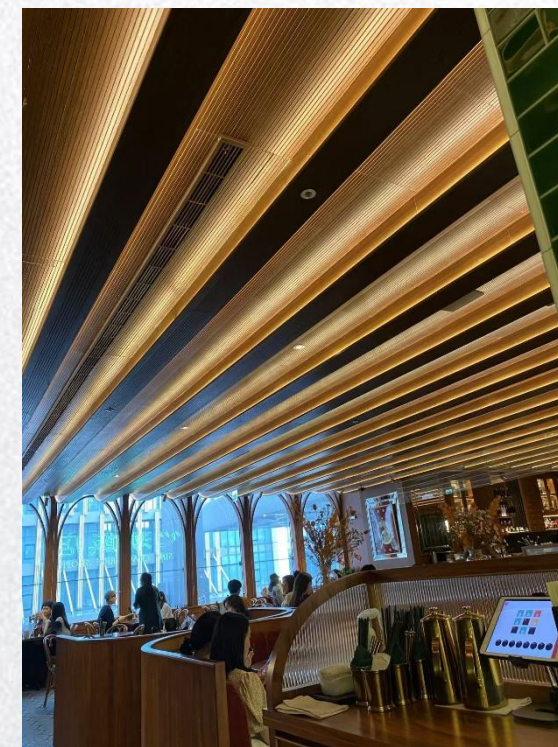
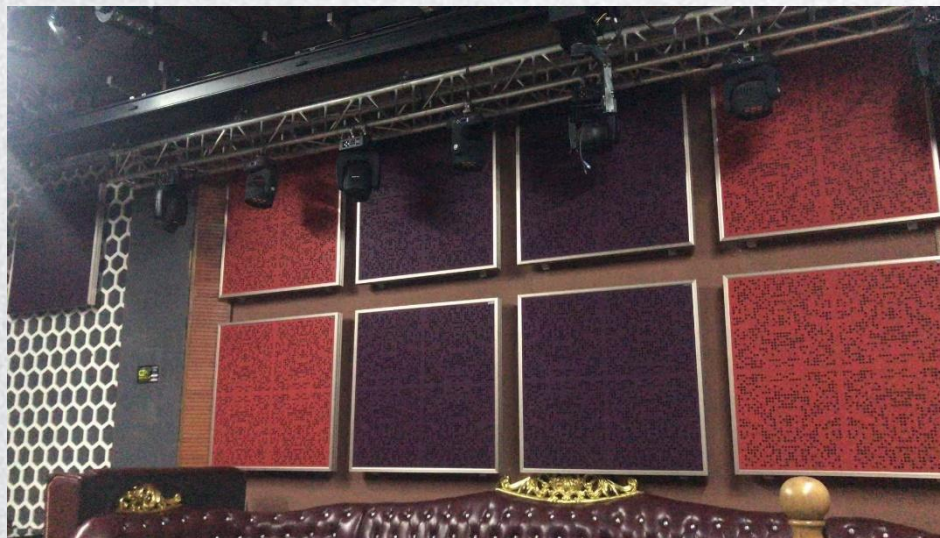


Downstairs received hits noise from the upper floors.
Measurement: 60.3dB

08

Acoustic Ideal Specifications -Reference Case 9

- Acoustic panels -Case sharing



✓ Reverberant panels can be installed on walls and ceilings to resolve indoor echoes.

08

Acoustic Ideal Specifications -Reference Case 10

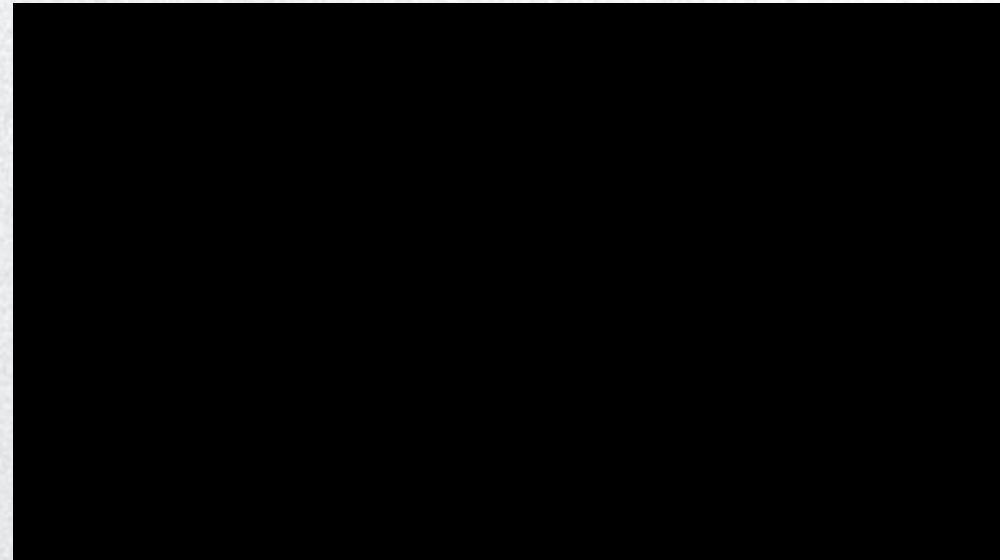
- Acoustic panels -Case sharing



Reverberant
Acoustic Panels
(Before Installation)



Reverberant
Acoustic Panels
(After Installation)



Reverberant Acoustic
Panels (Field test panels)

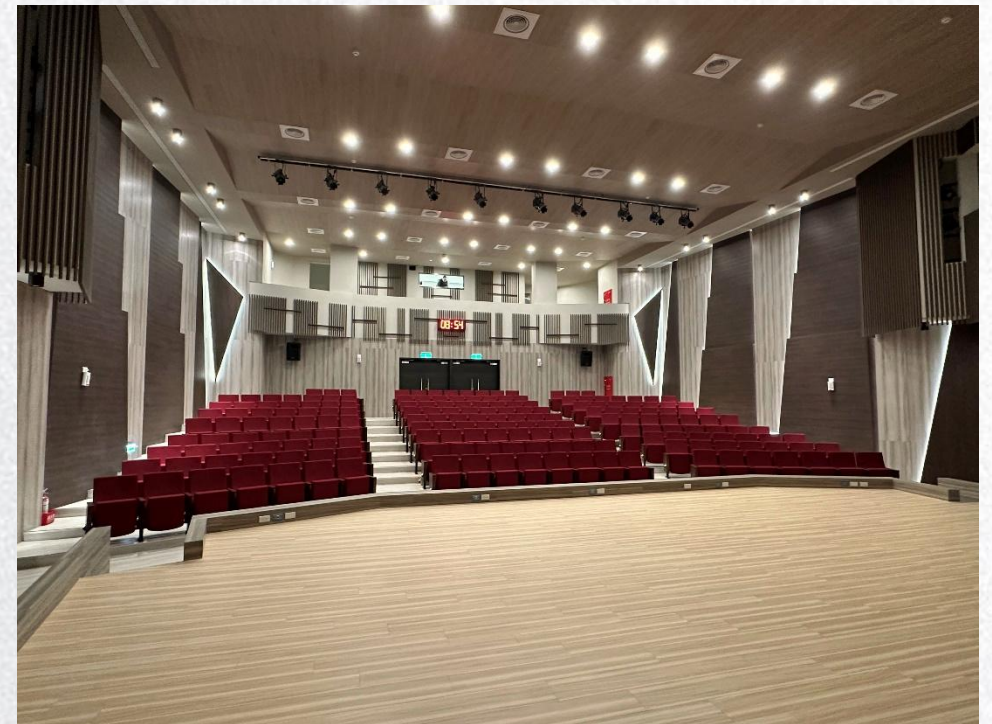
08

Acoustic Ideal Specifications -Reference Case 11

- The Affiliated Senior High School of National Taiwan Normal University-concert hall.



Art Performance by High-school Music Students of Normal University



Picture after construction

✓ Testing result : Dance stage R.T 0.7sec 500Hz, Auditorium R.T 0.9sec 500Hz



Thank you



Speaker : Mr. Fong Weng Chio
